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(58) Field of Search
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Dynamic Signal Processing

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(54) Monitoring landfill sites

(57) Parameters on a landfill site, such as local gas or water concentration, ground temperature or the presence of intruders, are monitored remotely by sensor units (44) in suitable locations on the site. Each sensor unit is linked by radio to an on-site control station (38), which may in turn be connected by telephone link to a remote master control station. Each sensor unit has at least one sensor (10) connected to a radio transmitter (18) through a signal processor (14), and transmits when a parameter exceeds a threshold value and/or when interrogated by radio. It is preferably solar powered.

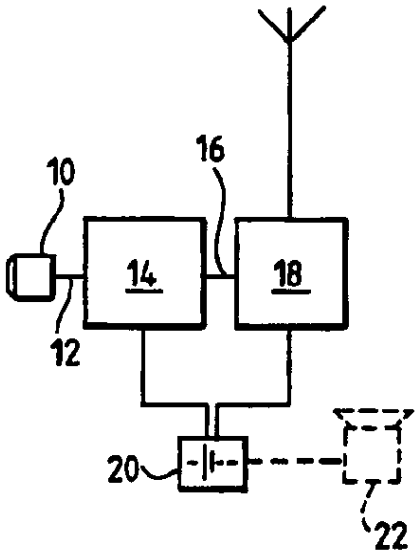

FIG.1.

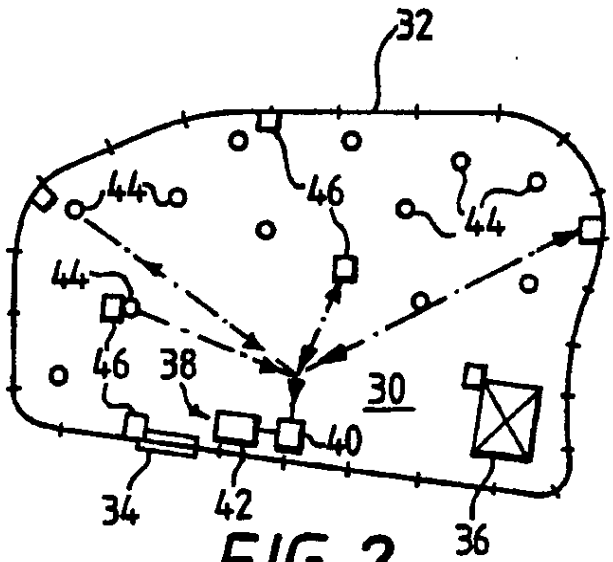

FIG.2.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1990.

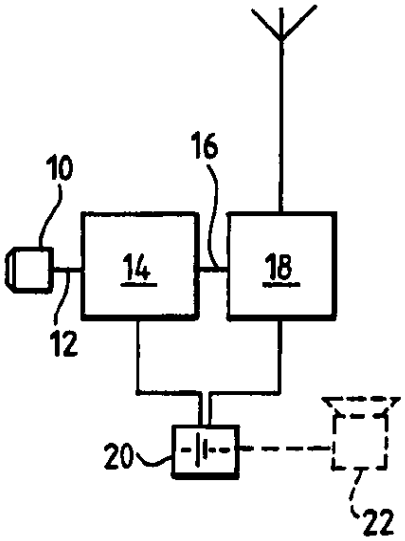

FIG.1.

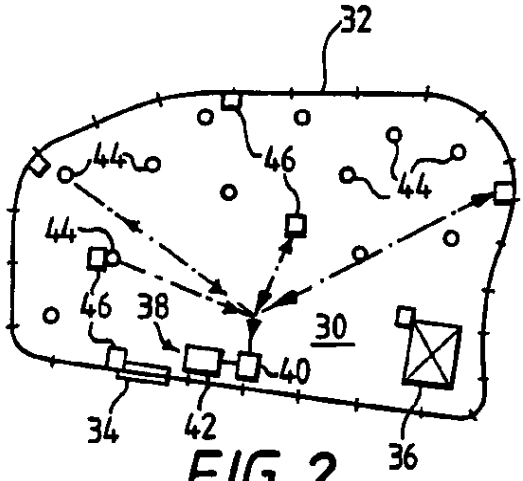

FIG.2.

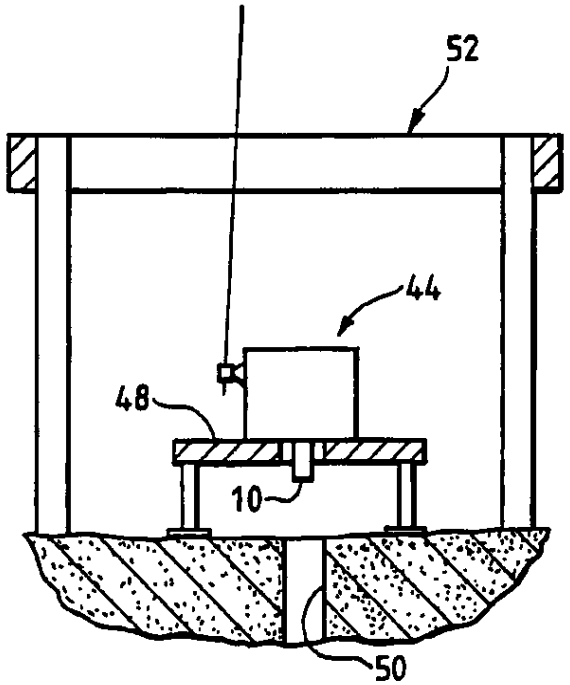

FIG.3.

MONITORING LANDFILL SITES

This invention relates to the monitoring, on landfill sites, of parameters which may, without limitation, typically comprise the presence, absence and local concentration of gases, local air or ground temperature, presence or absence of water or toxic liquids, and the presence of intruders.

Landfill sites are sites on which waste is dumped, this waste normally being mechanically compacted so that it becomes part of the ground, often to a very great depth. The waste usually comprises a wide variety of materials, and will typically include organic matter and/or various other substances which, by chemical interaction or by natural decay, tend to produce products such as gases which may be toxic or explosive, or otherwise noxious or harmful to the environment, or detrimental to the stability of the site itself.

It is therefore necessary to monitor the various parameters associated with these effects so that any necessary remedial action can be taken. Sometimes the need for such action is extremely urgent, e.g. if there is a concentration of a gas likely to start a fire spontaneously. The nature of landfill sites is such that there is usually quite a high fire risk.

Boreholes are conventionally sunk at various locations on the site, especially in the region of its perimeter with a view to detecting seepage of pollutants into the surrounding land.

Current practice is to monitor landfill sites by arranging regular inspections (typically at weekly

intervals) by personnel equipped with suitable detecting equipment, who move over the site to measure certain parameters such as those mentioned above, in particular at the boreholes. This reliance on personal monitoring has a number of disadvantages. First, although some landfill sites are manned, so that such inspections can be quite frequent, others are unmanned. On an unmanned site monitoring can only be carried out when someone visits the site, and even then only when that person is actually present. Thus, for example, a fire may break out when nobody is at the site, and may take hold seriously before an alarm can be raised.

In addition, landfill sites, especially unmanned ones, are susceptible to theft of dumped materials, machinery or other equipment, and unauthorised access by intruders is therefore an ever-present problem.

For these reasons it is currently necessary to provide a comparatively large number of personnel to protect a landfill site. It is not safe to leave it unattended for any extended period of time. The labour-intensiveness of maintaining what is after all merely a dump for unwanted waste creates a continuous cost over and above the cost involved in the operations of dumping material on the site. This is especially so after the site is full, and no longer regularly visited in the daytime for the purpose of dumping material.

An object of the present invention is to reduce the manpower requirement. Another object is to provide virtually immediate detection of situations requiring attention, such as unacceptable concentrations of explosive or toxic substances, or the presence of intruders.

According to the invention in a first aspect, a method of monitoring a parameter on a landfill site, comprises: locating at a location on the site a sensor unit having sensing means for the said parameter, signal processing means for producing output signals responsive to signals from the sensor means representing the state of the parameter, and a transmitter for automatically transmitting radio signals representing output signals of the processing means; receiving the radio signals at a central control station; and processing the information conveyed thereby.

In a second aspect, the invention provides a sensor unit as defined above.

The central control station is preferably on the site itself. It comprises a radio receiver coupled to a suitable processor, such as a computer programmed to analyse the signals received from a number of the sensor units located in different places on the site, and to cause (in any suitable way) information to be disseminated about the state of the parameter or parameters (usually the latter) being monitored. This dissemination may for example be by way of an audible or visual indication.

The on-site control station may be one of several on different landfill sites, incorporating transmitting means for relaying the information to a receiver feeding a further signal processing means at a master control station. The master control station can be some way from the various sites, and will normally be manned. The information from what may be a large number of sensor units on the various sites is then

available continuously to the operator at the master station, who can arrange for any remedial action to be taken, immediately if the information indicates an emergency. The link between one on-site control station and the master station may be an ordinary or dedicated telephone link.

The processing means in any sensor unit, and/or the processor at the on-site control station, and/or that at the master station if any, can be programmed in any suitable way. For example, each sensor unit may be arranged to transmit a radio signal in connection with a particular parameter, say the local temperature, or the concentration of a particular gas, ~~if it exceeds a~~ predetermined threshold value.

Preferably, however, each sensor unit includes radio receiving means, the central control station having radio transmitting means and its processor being programmed so as to send regular interrogation signals to the sensor units so as to monitor the correct operation of the latter.

In any case, it may be desired to obtain continuous information, or information at predetermined intervals (e.g. once every minute, or once every hour) from each sensor unit. The on-site control station processor and those in the sensor units can readily be arranged in known ways to perform this function, with that at the master station being similarly programmed if required.

The sensor units fall basically into two categories: borehole sensor units (BSU) and security sensor units (SSU). A borehole sensor unit will be placed in or close to a borehole on the site, and may contain a

number of sensors, typically with each sensor adapted to react to a different parameter. The processing means is then such as to recognise and distinguish the output signals of the various sensors. The radio signals from the unit will of course contain information identifying the parameter on which information is being sent.

The sensors in the borehole sensor units may typically be of known kinds sensitive to: atmospheric concentration of oxygen, carbon dioxide or methane; relative humidity; water level; temperature; atmospheric pressure.

There may be more than one SSU on each site, positioned for example on plant, machines, buildings or gates, or close to one or more of the borehole sensor units. The SSU sensor or sensors may be of any known type, for example the active or passive infra-red type, or the vibration, magnetic or contact types.

A sensor unit according to the invention may if desired be both a BSU and an SSU, having appropriate sensor means and signal processing means connected to a common radio transceiver.

Each sensor unit (of whatever kind) is preferably self-powered by means of a battery, preferably rechargeable, and may incorporate recharging means which is preferably of a known automatic type, e.g. a solar pack. The processing means of each unit is preferably arranged in a known way to transmit output signals, either automatically, e.g. continuously or at regular intervals, or on receipt of an interrogation signal from or via the on-site control station, indicating

whether or not there is a fault in the unit, and/or a tamper alarm signal.

The system may also include a security paging unit of any known kind, which can be carried by anyone within radio range of one or more sensor units. This paging unit will normally be in radio communication with the on-site control station. It could also be linked by radio to the sensor units, so as to give an audible and/or visual alarm in response to a signal from a sensor unit indicating the possible presence of an intruder and/or the fact that a predetermined threshold value of one of the physical parameters (gas concentration etc.) is being exceeded.

An embodiment of the invention will now be described, by way of example only and with reference to the accompanying drawings, in which:-

Figure 1 is a simplified block diagram of a sensor unit;

Figure 2 is a plan of a typical landfill site; and

Figure 3 is a simplified sectional elevation showing one arrangement for siting a borehole sensor unit.

The unit shown in Figure 1 is described in terms of a BSU, but it is to be understood that it may equally well be an SSU. It comprises a sensor head 10 containing several sensors (not shown) for detecting and measuring a variety of parameters such as those mentioned above. The output signals from the head 10, at 12, are processed by a processor 14, which generates a digital output signal at 16 when the value of any one of the parameters exceeds a threshold value. This

output signal is coded so as to identify the parameter and its instantaneous value and/or rate of change.

The signals at 16 are transmitted by a radio transceiver 18. Both the processor 14 and transceiver 18 are powered by a rechargeable battery pack 20, optionally kept charged by a solar recharging unit indicated at 22.

The site 30 in Figure 2 has a perimeter security fence 32 with a gate 34, and contains a plant shed 36 and a gatehouse (not shown) in which is an on-site central control station 38 comprising a radio transceiver 40 connected to a central processor 42. A number of boreholes are drilled in various locations on the site. A BSU 44, indicated by a small circle in Figure 2, is located in or adjacent to each borehole. A number of security sensor units 46, each indicated by a solid square in Figure 2, are arranged around the site in suitable positions. The two-way radio links between various sensor units 44, 46 and the transceiver 40 are indicated in phantom lines.

Figure 3 shows one of many possible ways of mounting a BSU 44 at a borehole. The unit 44 has a weatherproof casing, and its sensor head 10, in this example, projects downwardly from the base of the casing, through an opening in a support platform 48 so as to lie over the borehole, indicated at 50. A protective fence 52 is arranged around the borehole, as protection against collision by plant moving around the site.

CLAIMS

1. A method of monitoring a parameter on a landfill site, comprising: providing at a location on the site a sensor unit having sensing means for the said parameter, local signal processing means for producing output signals responsive to signals from the sensor means representing the state of the parameter, and a transmitter for transmitting radio signals representing output signals of the local processing means; receiving the radio signals at a control station; and processing the information conveyed thereby.

2. A method according to Claim 1, for a site where the control station is on the same site, wherein the information is analysed and disseminated at the on-site control station by a second processing means coupled to a receiver for the radio signals.

3. A method according to Claim 2, wherein dissemination of the analysed information comprises transmitting the latter by telephone link to a master control station.

4. A method according to Claim 3, for monitoring a parameter on a plurality of landfill sites, each having at least one said sensor unit and a said control station, including receiving the analysed information from each site by telephone link at the master control station.

5. A method according to any one of the preceding Claims, for a site having a plurality of the said sensor units disposed in various locations on the site, the radio receiver at the control station receiving

said output signals from all the sensor units on the site.

6. A method according to any one of the preceding Claims, for monitoring a plurality of parameters, at least one of the sensor units on the site having sensing means for two or more of the said parameters, the output signals being such as to distinguish the parameters from each other, with the second processing means analysing and disseminating information about each parameter.

7. A method according to any one of the preceding Claims, including the further step of transmitting interrogation signals from the control station to the sensor unit, so that the latter receives them as radio signals and, in response thereto, transmits a said output signal to the control station.

8. A method according to Claim 7, including transmitting the interrogation signals automatically and at predetermined intervals.

9. A method according to any one of Claims 1 to 6, wherein the local signal processing means are programmed with a predetermined threshold value of the said parameter, the sensor unit producing a said radio signal automatically when the parameter as detected by the associated sensing means exceeds the threshold value.

10. A sensor unit at a landfill site for use, by a method according to any one of the preceding Claims, in monitoring at least one parameter, including: sensing means for the said parameter or parameters; local

signal processing means connected to the sensing means for producing output signals responsive to signals from the sensing means representing the state of the or each paranmeter; a transmitter connected to the processing means for transmitting radio signals representing the said output signals; and power supply means for the sensing means, local signal processing means and transmitter.

11. A sensor unit according to Claim 10, wherein the power supply means comprise means for converting solar energy to electrical energy.

12. A sensor unit according to Claim 11, wherein the power supply means further include at least one rechargeable electric battery coupled to the solar conversion means so as to be charged by the latter.

13. A sensor unit according to any one of Claims 10 to 12, further including a radio receiver for receiving interrogation signals, the local signal processing means being adapted to transmit a said radio signal in response to a said interrogation signal.

14. A sensor unit according to any one of Claims 10 to 13, wherein the local signal processing means is adapted to cause a said radio signal to be transmitted when the value of at least one parameter, as detected by the sensing means, exceeds a predetermined threshold value.

15. A method of monitoring at least one parameter on at least one landfill site, substantially as described in the foregoing description with reference to the accompanying drawings.

16. A method according to any one of Claims 1 to 9 or Claim 15, further including providing a paging unit at the site for receiving output signals from said sensor units on the site and/or in radio communication with the control station to receive signals therefrom; and giving an alarm by means of the paging unit in reponse to a said signal indicating the possible presence of an intruder or that a predetermined threshold value of a said parameter is exceeded.

17. Apparatus for monitoring at least one parameter on a landfill site, arranged and adapted to operate substantially as described in the foregoing description with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

Application number
GB 9226400.1

Relevant Technical Fields

(i) UK Cl (Ed.L) G4H (HNEA, HNEB, HNEC, HNED, HNEE,HNEF, HNEG, HNEH, HNEJ, HNEL, HNEM, HNHE), H4K (KOC)

(ii) Int Cl (Ed.5) G08B

Search Examiner
M J DAVIS

Date of completion of Search
13 OCTOBER 1993

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-17

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2256042 A	(SIEMENS PLESSEY) - whole document	1-17
X	GB 2190192 A	(NEWTON) - whole document	1-17
X	GB 1485117	(EMI) - whole document	1-17
X	GB 1393122	(WESTINGHOUSE ELECTRIC) - whole document	1-17
X	WO 88/09560 A1	(BATTELLE) - whole document	1-17

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